Maryland Forest Service

Environmental and Social Risk Assessment:

Imazamox

December, 2024

Environmental Assessment

Pesticide:	Imazamox		***Specific Formulation:***
Hazard Status:	Imazamox is a slightly hazardous chemical pesticide, and is considered a Class III pesticide based on its classification in the Acute Toxicity hazard group. It is not considered a highly hazardous pesticide (HHP) per the FSC Pesticides Policy (FSC-POL-30-001 V3-0 EN) and the FSC Lists of Highly Hazardous Pesticides (FSC-POL-30-001a EN).		Alligare IMOX™ Herbicide, Clearcast® CAS no. 247057-22-3 [ammonium salt] Raptor™ Herbicide CAS no 114311-32-9 [acid]. NOTE: 12.1% active ingredient (ammonium salt of imazamox; equivalent to 11.4% of the acid)
Exposure Elements	**Minimum list of values**	**Description of why/why not a risk on the Management Unit**	**Management Unit Mitigation strategies defined to minimize risk**
Environmental	**Soil (erosion, degradation, biota, carbon storage)**	**Minimal indication of adverse effects to soils was found when Imazamox is used according to label instructions in forestry applications.** Based on modeling, the average soil column penetration depth of imazamox is estimated at about 40 inches with a range of about 12-29 60 inches. The deepest penetration is in sand soils, followed by loams and clays. Gleams-Driver modeling indicated no runoff loss in sandy soils or other soils with low rainfall rates. Maximum runoff proportion in 100 individual simulations occurred for areas with predominantly clay soils, cool temperatures, and high rainfall.(1) The Aerobic soil half-life was found to be 28 days [cited as 27 days in U.S.EPA/OPP 2008a] (1,2). A report prepared for the US Forest Service found the European Commission (2002) indicates that imazamox has no effect on nitrogen metabolism or carbon mineralization when applied at rates of 150 g/ha (equivalent to rates of 8 about 0.13 lb a.e./acre) The reported study results do not suggest a hazard to terrestrial arthropods (1). An evaluation by the University of Wisconsin-Madison stated that Imazamox “is readily absorbed to the soil surface, so may provide residual control for a time, but it is unlikely to display activity through the entire season as it actively breaks down and is bound tightly to the soils” (3).	There is no national guidance ESRA for Imazamox herbicides. Maryland Forest Service Staff will do the following: **Follow all pesticide label application instructions**. Follow applicable criterion and indicators from the FSC US FM Standard V1.0 (e.g., Criterion 4.3 for worker safety, Criterion 7.3 for worker training, Criterion 6.5 for protecting water resources, and Criteria 8.1 and 8.2 for Monitoring). Applicators or persons supervising application of restricted use pesticides are required to be certified in accordance with EPA regulations and state, territorial and tribal laws. **General consideration of exposure variables designed to mitigate risk**: - Know and understand the specific pesticide formulation and/or tank mixture, as its unique formulation may provide a different risk characterization. - Understand how the

	Water (ground water, surface waters, water supplies)	**Minimal indication of adverse effects to water was found when Imazamox is used according to label instructions in forestry applications.** The EPA found that test results indicate that imazamox is “practically nontoxic” to finfish and aquatic invertebrates (2) An evaluation by the University of Wisconsin-Madison stated that Imazamox photodegrades rapidly in water with a half-life of 6.8 hours (4). The US EPA uses the First Index Reservoir Screening Tool (FIRST) or the Pesticide Root Zone/Exposure Analysis Modeling System (PRZM/EXAMS), to produce estimates of pesticide concentrations in an index reservoir. Based on the FIRST and SCI-GROW models the estimated environmental concentrations (EECs) for imazamox for acute exposures are estimated to be 5.7 parts per billion (ppb) for surface water and 1.0 ppb for ground water. The EECs for chronic exposures are estimated to be 0.61 ppb for surface water and 1.0 ppb for ground water. (3)	mixture of active ingredients affects the pesticides risk profile. -Seek to minimize the frequency, interval, and amount of application. -use the most efficient and effective method of application by seeking to minimize risk to environmental and social values. -Understand the site (e.g., soil type, topography, etc.) and climatic (e.g., wind, temperature, and humidity) conditions and the likely effect on risk to environmental and social values. -Have appropriate waste management systems in place. Follow the label for application. IMOX is harmful if absorbed through skin or inhaled. Causes moderate eye irritation (6). --Avoid breathing spray mist. Avoid contact with skin, eyes or clothing (6). --Use recommended PPE when applying. **Mitigating Risk to the Environment**: reduce contact with water resources and minimize application amounts and number of applications. -- Do not apply to water except as specified in the pesticide label (6). --Do not contaminate water when disposing of equipment washwater and rinsate (6). --Do not apply more that 1 pound of Imazamox acid equivalent (1 gallon) per acre per year (6). --Do not exceed 2 applications of Alligare IMOX Herbicide per year (6). --The minimum retreatment interval is 14 days (6). **Mitigating Risk to Public Access/Public Welfare**: -
	Atmosphere (air quality, greenhouse gasses)	**Minimal indication of adverse effects to atmosphere was found when Imazamox is used according to label instructions in forestry applications.** U.S. EPA classifies imazamox (both the a.e. and the formulation) as “Category IV”, the minimal classification for acute inhalation toxicity (1). There is a slight risk indicated by the manufacturer that the IMOX™ mixture may “thermally decompose in fire, releasing irritating and toxic gases such as oxides of carbon and nitrogen.” It may also thermally degrade in storage temperatures greater than 100 degrees F (6).	
Environmental	**Non-target species (vegetation, wildlife, bees and other pollinators, pets)**	**Minimal indication of adverse effects to non-target species was found when Imazamox is used according to label instructions in forestry applications.** As an herbicide, Imazamox should be considered hazardous to non-target plant	

		species (1). EPA found the Level of Concern (LOC) was exceeded for listed and non-listed non-target plant species that received spray drift from Imazamox use (2). Imazamox is hazardous to terrestrial macrophytes and as such nontarget macrophytes are at risk for spray drift and direct spray (1). The US Forest Service cited a study (Parrish et al. 1994) that found mortality was low in all dose groups of bees (from 0 to <5%) and that no dose-response relationship for mortality or any other effect was apparent. The USFS indicated the study by Parrish et al. (1994) is classified as "core", a term synonymous with acceptable. (1) The EPA found that test results indicate that imazamox is "practically nontoxic" to avian species, finfish, aquatic invertebrates, and honeybees following acute exposure (2). However, the MSDS for IMOX states it is "very toxic to aquatic life" (6). The Wisconsin Department of Agronomy states Imazamox should be "considered non-selective and have the potential to cause injury to any species that absorbs this pesticide." Significant non-target injury could occur if treated water moves off-site, but very confident that if the label is followed negative impacts are minimized if not eliminated (4).	Reduce the possibility of public consumption of contaminated wild food (e.g., fruit or fungi) and public exposure to pesticides through public outreach and engagement, limiting access, and/or appropriate signage. For instance, users of the forest may be excluded from the area using barriers or signage until the pesticide dries. --Do not mix or allow to come into contact with oxidizing agents (6) --Follow all storage and disposal label instructions (6). --Do not store in areas subject to temperature above 100 degrees F. **Minimizing Risk to Non-Target Species:** Do not apply to water that may move. Be sure that any water has no chance of movement for several days before treating an area with standing water. Follow labeled instructions to prevent movement through spray drift or through treated water. (4). -- Do not apply to water except as specified in the pesticide label (6). --Do not contaminate water when disposing of equipment washwater and rinsate (6). This pesticide may be hazardous to plants outside the treated area. Consult the Maryland Wildlife and Heritage Service or the Fisheries Service prior to treating areas in Ecologically Significant Areas (ESA) or areas designated as Irreplaceable Natural Areas (INA).
	Non-timber forest products (as FSC-STD-01-001 V5-2 FSC Principles and Criteria, criterion 5.1)	**Minimal indication of adverse effects to Non-timber forest products found for Imazamox when used according to label instructions.** There are no NTFPs produced on Maryland state forests, however studies suggest minimal risk to any NTFPs as long as spray drift is controlled. EPA found the Level of Concern (LOC) was exceeded for listed and non-listed non-target plant species that received spray drift from Imazamox use (2).	
	High Conservation Values (particularly HCV 1-4)	**Minimal indication of adverse effects to high conservation values found for Imazamox when used according to label instructions.** It should be expected that Injury and death to rare, threatened, or endangered plant species is likely to occur if applied directly. There is a risk of spray drift, but these risks	

		are minimal if application is planned and performed according to the label instructions. An EPA ecological risk assessment of Clearcast indicated there is no basis for asserting that the use of surfactants with Clearcast applications is likely to pose a hazard to aquatic species. The study further found that using a very toxic surfactant with an acute LC50 of 1 mg/L in aquatic applications of Clearcast would result in peak exposures that are below the U.S. EPA/OPP level of concern for threatened and endangered species by a factor of about 5. (1) The EPA found that hazard to nontarget organisms is considered to be minimal (1). EPA found the Level of Concern (LOC) was exceeded for listed and non-listed non-target plant species that received spray drift from Imazamox use (2).	Staff should be mindful of the presence of HCVs on the landscape and the potential Imazamox has to impact them. Consider all environmental factors prior to application in order to eliminate the potential for negative impacts to HCVs. To prevent potential negative impacts to endangered plant species, Do not apply in a way that adversely affects federally listed endangered and threatened species (6). **Minimizing Risk of Spray Drift:** *unintentional spray drift has potential to significantly increase risk to the environment and public welfare.* <u>Aerial Applications</u> --Do not release spray at a height greater than 10 ft above the vegetative canopy, unless a greater application height is necessary for pilot safety (6). --For all applications, applicators are required to use a Coarse or coarser droplet size (ASABE S572.1) (6). --The boom length must not exceed 65% of the wingspan for airplanes or 75% of the rotor blade diameter for helicopters (6). --Applicators must use ½ swath displacement upwind at the downwind edge of the application site (6). --Nozzles must be oriented so the spray is directed toward the back of the aircraft (6). --Do not apply when wind speeds exceed 10 miles per hour at the application site (6). --Do not apply during temperature inversions (6). <u>Ground Applications</u>
	Landscape (aesthetics, cumulative impacts)	**Minimal indication of adverse effects to high conservation values found for Imazamox when used according to label instructions.**	
	Ecosystem services (water, soil, carbon sequestration, tourism)	**Minimal indication of adverse effects to ecosystem services found for Imazamox when used according to label instructions.** See above for soil and water considerations. Imazamox has a relatively low potential for bioconcentration, and concentrations of imazamox in edible fish tissue were below the limit of quantification (1).	

			--Apply with the nozzle height recommended by the manufacturer, but no more than 3 feet above existing terrestrial or aquatic vegetation (6). --For all applications, applicators are required to use a Coarse or coarser droplet size (ASABE S572.1) (6). --Do not apply when wind speeds exceed 10 miles per hour at the application site (6). --Do not apply during temperature inversions (6).

Sources:

(1) SERA, 2010. Imazamox: Human Health and Ecological Risk Assessment, Final Report. Syracuse Environmental Research Associates, Inc. (SERA). Submitted by Patrick R. Durkin to USDA Forest Service. Accessed at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-24-02a_Imazamox.pdf

(2) U.S. Environmental Protection Agency/Office of Pesticide Programs. 2008. Environmental Fate and Effects Science Chapter: Environmental Fate and Ecological Risk Assessment: Registration of New Use Imazamox for the proposed new use for the control of weed in Clearfield rice (imidazolinone-tolerant rice). Document dated 9/24/2008. USEPA PC Code: 12971. Environment Risk Branch II Team: I. Abdel-Saheb, and M. Davy, Environmental Fate and Effects Division. Available Online: https://archive.epa.gov/pesticides/chemicalsearch/chemical/foia/web/html/129171.html

(3) USEPA, 2003. Imazamox; Exemption from the requirement for a tolerance. Accessed online: https://federalregister.gov/a/03-3699.

(4) Imazamox Fact Sheet, 2019. Memo to WI DNR Pesticide Use Advisory Team. University of Wisconsin-Madison, College of Agriculture and Life Sciences. Accessed online: https://dnr.wisconsin.gov/topic/lakes/plants/factsheets

(5) USEPA, 1997. Imazamox Pesticide Fact Sheet. Available at: https://www3.epa.gov/pesticides/chem_search/reg_actions/registration/fs_PC-129171_22-May-97.pdf

(6) Alligare IMOX™ Herbicide Specimen Label Accessed Online: https://alligare.com/wp-content/uploads/2024/06/Imox-2.5Gal-Book_customer-copy.pdf

(7) Pesticide residues in food - 2014: toxicological evaluations / Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group on Pesticide Residues, Rome, Italy, 16–25 September 2014. Available Online: https://iris.who.int/handle/10665/164597

Social Assessment

Pesticide:	Imazamox		***Specific Formulation:***
Hazard Status:	Imazamox is a slightly hazardous chemical pesticide, and is considered a Class III pesticide based on its classification in the Acute Toxicity hazard group. It is not considered a highly hazardous pesticide (HHP) per the FSC Pesticides Policy (FSC-POL-30-001 V3-0 EN) and the FSC Lists of Highly Hazardous Pesticides (FSC-POL-30-001a EN).		Alligare IMOX™ Herbicide, Clearcast® CAS no. 247057-22-3 [ammonium salt] Raptor™ Herbicide CAS no 114311-32-9 [acid]. NOTE: 12.1% active ingredient (ammonium salt of imazamox; equivalent to 11.4% of the acid)
Exposure Elements	**Minimum list of values**	**Description of why/why not a risk on the Management Unit**	**Management Unit Mitigation strategies defined to minimize risk**

	High Conservation Values (especially HCV 5-6)	**Minimal indication of adverse effects to high conservation values was found when Imazamox is used according to label instructions in forestry applications. Additional considerations are provided below.** Unintentional secondary effects on habitat, landscape and ecosystem are possible due to changes in vegetation (1). The EPA found that hazard to nontarget animals is considered to be minimal (1).	**Follow all pesticide label application instructions. Follow applicable criterion and indicators from the FSC US FM Standard V1.0 (e.g., Criterion 4.3 for worker safety, Criterion 7.3 for worker training, Criterion 6.5 for protecting water resources, and Criteria 8.1 and 8.2 for Monitoring). Additional risk mitigation strategies are provided below. Organizations should take reasonable steps toward avoiding environmental and social impacts by considering the mitigation strategies provided below, as well as application-, Organization-, or location-specific strategies. General consideration of exposure variables designed to mitigate risk:** Know and understand the specific pesticide formulation and/or tank mixture, as its unique formulation may provide a different risk characterization. -Understand how the mixture of active ingredients affects the pesticides risk profile. -Seek to minimize the frequency, interval, and amount of application. -use the most efficient and effective method of application by seeking to minimize risk to environmental and social values. -Understand the site (e.g., soil type, topography, etc.) and climatic (e.g., wind, temperature, and humidity) conditions and the likely effect on risk to environmental and social values. -Have appropriate waste management systems in place. Maryland Forest Service staff will include a buffer when deemed appropriate to the needs of the community and for cultural values. For example, cemeteries are always buffered during operations.
	Health (fertility, reproductive health, respiratory health, dermatologic, neurological and gastrointestinal problems, cancer and hormonal imbalance)	The US Forest Service found that there is no basis for asserting that applications of imazamox posses any substantial risk to humans. No anticipated exposures of humans or mammalian wildlife to imazamox raise concern (1). *Acute exposure:* EPA dietary risk assessments are performed for a food-use pesticide if a toxicological study has indicated the possibility of an effect of concern occurring as a result of a one day or single exposure. **EPA concluded that no acute toxicological endpoint was identified from the toxicological studies submitted for imazamox**, including oral developmental toxicity studies in rats and rabbits. Therefore, an acute dietary risk assessment was not conducted [by the US EPA]. (3) *Chronic exposure*. EPA concluded that a chronic dietary risk assessment is not needed since **no toxicity was observed at doses exceeding the Limit-Dose** (1,000 mg/kg/day and higher) in chronic and subchronic studies in mice, rats, and dogs. A dose of 1,000 mg/kg/day is equivalent to a human diet in which the pesticide comprises approximately 7 percent of dietary consumption. (3)	

		The Wisconsin Department of Agronomy concurs with the USFS and EPA opinion and stated: "that it can cause harm by dermal exposure these risks have been found to be acceptable for the proposed use patterns if appropriate personal protective equipment is used. No long-term chronic effects have been found to be of concern." (4) The EPA factsheet for Raptor™ herbicide (Imazamox acid) was found to be relatively non-toxic by the oral and inhalation routes and slightly toxic by the dermal route. These products are non-sensitizers and are non-to-slightly irritating to the skin. The aqueous solution formulation is non-to-slightly irritating to the eye and the dispersible granule formulation is slightly-to-moderately irritating to the eye (5). *Cancer*. **Imazamox is classified as a "not likely human carcinogen" based on the lack of evidence of carcinogenicity** in mice and rats. Therefore a cancer risk assessment was not performed [by the US EPA]. (3). A joint report by the FAO/WHO indicated "No carcinogenic effects were reported for the test material up to the highest dose level tested." (7).	**Mitigating Risk to Workers:** *Label instructions should be followed when applying pesticides.* Applicators and other handlers must wear: --Long-sleeved shirt and long pants (6). --Chemical-resistant gloves such as barrier laminate, butyl rubber N 14 mils, nitrile rubber N 14 mils, neoprene rubber N 14 mils, natural rubber (includes natural rubber blends and laminates) N 14 mils, polyethylene, polyvinyl chloride (PVC) N 14 mils, or viton N 14 mils (6). --Shoes plus socks (6). *Follow manufacturer's instructions for cleaning and maintaining PPE*. --If no such instructions for washables exist, use detergent and hot water (6). --Keep and wash PPE seprately from other laundry (6). --Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet (6). --Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put clean clothing (6). --Remove PPE immediately after handling this product. Wash the outside of the gloves before removing. As soon as possible, wash thoroughly and change into clean clothing (6). **Mitigating Risk to Public Access/Public Welfare:** Reduce the possibility of public consumption of contaminated wild food (e.g., fruit or fungi) and public exposure to pesticides through public outreach and engagement, limiting access, and/or appropriate signage. For instance, users of the forest may be excluded from the area using
Social	**Welfare**	**Minimal indication of adverse effects to welfare was found when imazamox is used according to label instructions in forestry applications.**	
	Food and water	EPA concluded that imazamox showed no toxicological endpoints of concern and, therefore, no dietary, occupational, residential, or aggregate risk assessments were needed. (3). EPA found no adverse effects were observed in the submitted toxicological studies regardless of the route of exposure. **EPA does not expect imazamox to pose a dietary risk under reasonable**	

		foreseeable circumstances and, thus, EPA concludes that there is a reasonable certainty of no harm from aggregate exposure to imazamox residues (3). The Wisconsin Department of Agronomy indicated this product can be moderately persistent in the environment, but it degrades aerobically by microbes in the soil and photodegrades rapidly in water (half-life 6.8 hours), thus EPA has limited concern about persistence or movement into groundwater (3).	barriers or signage until the pesticide dries. --Do not mix or allow to come into contact with oxidizing agents (6). --Follow all storage and disposal label instructions (6). --Although not listed on the label for IMOX avoid storing in areas subject to temperature above 100 degrees F. **Minimizing Risk of Spray Drift:** *unintentional spray drift has potential to significantly increase risk to the environment and public welfare.* <u>Aerial Applications</u> --Do not release spray at a height greater than 10 ft above the vegetative canopy, unless a greater application height is necessary for pilot safety (6). --For all applications, applicators are required to use a Coarse or coarser droplet size (ASABE S572.1) (6). --The boom length must not exceed 65% of the wingspan for airplanes or 75% of the rotor blade diameter for helicopters (6). --Applicators must use ½ swath displacement upwind at the downwind edge of the application site (6). --Nozzles must be oriented so the spray is directed toward the back of the aircraft (6). --Do not apply when wind speeds exceed 10 miles per hour at the application site (6). --Do not apply during temperature inversions (6). <u>Ground Applications</u> --Apply with the nozzle height recommended by the manufacturer, but no more than 3 feet above existing terrestrial or aquatic vegetation (6). --For all applications, applicators are required to use a Coarse or coarser droplet size (ASABE S572.1) (6).
	Social Infrastructure; (schools and hospitals, recreational infrastructure, infrastructure adjacent to the management unit)	Due to the lack of toxicity in the animal studies, EPA did not use a margin of exposure (safety) approach to assess the safety of imazamox. EPA found that an additional margin of safety is not needed for infants and children. **The Agency concluded that an exemption from the requirement of a tolerance for imazamox will be safe for infants and children** (3). EPA also found there were no international “established or proposed Codex Maximum Residue Limits (MRLs) for imazamox.” (3).	
	Economic viability (agriculture, livestock, tourism)	**Minimal indication of adverse effects to economic viability was found when Imazamox is used according to label instructions in forestry applications.** There is a potential for spray drift to adversely affect sensitive terrestrial and aquatic plant species. According to the US Federal Register, the herbicide imazamox, (±) 2, -[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid, is exempt from the requirement of a tolerance on all food commodities when applied as a herbicide in accordance with good agricultural practices (3).	

	Rights (legal and customary)	**Minimal indication of adverse effects to rights was found when imazamox is used according to label instructions in forestry applications.**	--Do not apply when wind speeds exceed 10 miles per hour at the application site (6). --Do not apply during temperature inversions (6).
	Others	No additional values were identified in this assessment.	

Sources:

(1) SERA, 2010. Imazamox: Human Health and Ecological Risk Assessment, Final Report. Syracuse Environmental Research Associates, Inc. (SERA). Submitted by Patrick R. Durkin to USDA Forest Service. Accessed at: http://www.fs.fed.us/foresthealth/pesticide/pdfs/052-24-02a_Imazamox.pdf

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(3) USEPA, 2003. Imazamox; Exemption from the requirement for a tolerance. Accessed online: https://federalregister.gov/a/03-3699.

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(6) Alligare IMOX™ Herbicide Specimen Label Accessed Online: https://alligare.com/wp-content/uploads/2024/06/Imox-2.5Gal-Book_customer-copy.pdf

(7) Pesticide residues in food - 2014: toxicological evaluations / Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Core Assessment Group on Pesticide Residues, Rome, Italy, 16–25 September 2014. Available Online: https://iris.who.int/handle/10665/164597